



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

There has been much talk during the last few years among medical men, and especially among those engaged in public health work, regarding the control of tuberculosis. The action of the Minnesota State Board of Health seems to be one of the most logical and sincere efforts to control the disease made by any health department. The results obtained in Minnesota during the next few years will naturally be watched with much interest by all associated with public health administration.

SAFE ICE.

By HUGH S. CUMMING, Surgeon, United States Public Health Service.

From the earliest dawn of civilization, dwellers in temperate regions have during the winter months stored ice for use in the preservation of food or in making articles of diet more agreeable to the taste during the hot season.

The Hindu in the northern Provinces of India from time immemorial has wrapped his porous jug, filled with water boiled to expel air, with wetted cloths, the evaporation from which makes ice during cold, clear nights. The Indian of the Tropics and the cowboy of the plains still take advantage of the abstraction of heat by evaporation.

Romance tells us how the chivalrous Saracen, Saladin, sent to his crusader enemy, him of the lion heart, snow ice from the mountains to assuage his fever. But until the last century the storing and use of ice was a merely local matter.

The growth of large urban populations which depend upon rural communities for food, the settling and development of such great agricultural fields as those of America, Australia, and Argentina, the increase of prosperity and greater demand for foods, and, most important, the increase of transportation facilities which allow the interchange of various forms of wealth, have all served to create a demand for ice. As a result, a great industry has been created and the streams and lakes of New England and the Northern States as well as the lakes of northern Europe are lined with great storehouses in which, by the industry of thousands of men, ice is packed during the winter to be carried later by vessel and train to inland communities and to far-distant regions. Indeed, the natural-ice trade has a romance of its own.

With the increased necessity for transporting food long distances, and demand for ice in places to which it was difficult to deliver natural ice, attempts were made to invent some practicable method of artificially producing ice. About 1868 Carre invented his ice machine, and later Dr. Gorrie, whose statue now in Statuary Hall in the National Capitol at Washington shows Florida's appreciation of his worth, increased its usefulness.

It was not until the late eighties, however, that the artificial production of ice became a commercial success. Within these thirty-odd years methods have been perfected until nearly every hamlet in our great country has its ice supply and none but the poorest and most isolated of our people are deprived of its blessings. Vessels and trains transport perishable food everywhere. The very existence of large cities depends upon it. The dweller in the city enjoys at small cost the meats of the plains and the fruits of the Tropics, while the traveler in the Tropics may have the meats and fruits of his native land.

Importance of Determining the Sanitary Safety of Ice.

While it is unusual abroad to place ice in drinks and food, it is the universal custom in our country to drink ice water, to use crushed ice in our "soft" and other drinks, and to apply it directly to foods which are eaten cold and uncooked.

It is used in every household and has come into contact with many of our foods before we secure them. Sanitarians and intelligent people generally now know the important part played by food in conveying the infection of preventable diseases, such as typhoid fever, dysentery, and other intestinal diseases. Some outbreaks of these diseases have been attributed to ice, and it seems pertinent, therefore, to decide whether there be danger to the individual in the use of this important article of diet, and if so to decide how such danger may be eliminated or avoided.

This is best determined by studying the sources from which ice comes; the physical and biological changes accompanying or consequent upon its formation; the methods employed in its collection or manufacture and handling; and the bearing of all these upon the probable danger of the conveyance of infection.

Physical Properties.

It is commonly known that at ordinary temperature and pressure water is a fluid, that if sufficient heat be applied it becomes a gas (steam), and that if sufficient heat be abstracted it becomes a solid (ice).

The temperatures at which these phenomena occur depend upon several factors, among which are pressure of the atmosphere or other surrounding medium and the purity of the water. The presence of air or any dissolved salts will lower the required temperature; for instance, sea water freezes at -2.8° C.

This phenomenon is applied to many practical purposes. "Brine," or water with salts in it, while still fluid but below 0° C. is used to refrigerate by passing it through pipes in an insulated room or car and for freezing water for artificial ice, and the housewife knows that salt added to the ice helps to freeze her ice cream.

Another important physical phenomenon is the latent heat of melting. It takes as much heat to change ice to water, both at 0°C. , as to raise the water from 0° to 79° . This is called "latent heat," and this phenomenon is responsible for the cooling properties of ice.

Formation of Ice.

Whatever the means, whether it be the crude effort of the Hindu or the various machines which utilize the alternate compression and expansion of gases, such as ammonia or even air itself, to create a low temperature in pipes or fluid surrounding water, or whether it be the cold winds which sweep down from the dark, frigid regions of eternal cold, but one principle is involved in the formation of ice, which is that when two substances of unequal temperature are in contact the warmer substance gives up heat until both are of the same temperature.

Ice therefore is the result of the abstraction of heat from water. When this occurs the shapeless fluid is transformed into beautiful solid crystals which, compacted together, we call the solid "ice."

Important phenomena occur during this change. First, like most other substances, water contracts as it grows colder until it reaches 4°C. , or 39.1°F. It then begins to expand, so that ice is lighter than water. Were this not true our northern waters would be frozen from the bottom and all fish killed.

The second phenomenon, one common to the crystallization of all substances, and one well known to chemists, but until recently overlooked by sanitarians, is that during crystallization nearly all extraneous substances either in suspension or solution are expelled from the crystal; indeed, crystallization is a common method employed by chemists to obtain chemically pure substances. We shall presently show how important is this truth.

Sources of Ice Supply and Methods of Collection and Manufacture.

The ice which is sold in cities is derived from two general sources and is either "natural" or "artificial" ice.

Natural ice.—Along the banks of many of our northern rivers and lakes are large houses in which are stored for future shipment ice cut into convenient size blocks, separated by straw, chaff, or paper. When ice has formed sufficiently thick it is cut by saws and hauled by horses and machinery to the houses. The men, horses, and dust form a necessary source of pollution, much of which is visible, and to obviate danger from this source the laws of some States, and rules of an association which comprises the majority of important producers of natural ice, require that the top of the ice shall be cut or shaved off just before it is stored. Unless ice is scarce, cloudy or dirty ice is also rejected, because it keeps badly and is not desired by

purchasers. Such ice remains in storage for months and is then shipped.

In addition to such sources of natural ice, much ice is cut from ponds for use by farmers, butchers, and dairymen, and such ponds are often grossly polluted.

While there are many exceptions, it is undoubtedly true that much natural ice is cut from rivers or ponds more or less polluted by man.

Artificial or Mechanically Made Ice.

The various methods of cooling the brine or other substances in ice machines do not necessarily affect the sanitary qualities of the ice, but the two methods of applying water to be frozen are quite important. They are called the "can" and the "plate" methods. In the former method water is placed in cans submerged in brine maintained below 0° and kept there for a time dependent upon the size of the can.

As has been stated, freezing expels almost all of the impurities, but as the can is full the impurities present are impelled toward the center and top of the can as the surfaces nearest the brine freeze first. Even air causes cloudiness and the presence of iron salts a red and of lime and magnesium a whitish core. To obviate this and secure pure, clear ice, the water is generally distilled, the water from the condensers furnishing over half of the amount necessary. Of course, distillation destroys all disease organisms present in the water.

Recently, however, in one system the cans have been made larger and an air pipe passed down the center, the cakes later being cut into smaller ones, eliminating the dirty core.

In another can system about 6 inches of water is kept fluid by agitation by air pipes and thus a liquid remains into which impurities are expelled.

Both of these systems are held to eliminate the necessity for distillation of water, and this is a fact to be remembered.

Plate ice.—There are large tanks containing water, on one side of which is a system of pipes containing the freezing mixture. The water freezes next the pipes into plates generally 16 by 8 feet and which are cut or melted off when they reach 11 inches in thickness. This takes about seven days at the usual temperature and the ice is clear, as the air and other impurities have been driven out into the adjacent water.

In this method, as in the newer can methods, it is necessary to filter the water but not to distill it. In both methods insulated tops are necessary and there is generally necessity for workmen to walk over the tanks, thus affording opportunity for pollution from dirty hands

and from boots which may have been in street and stable dirt. To obviate this, many factories require their workmen to enter an outer room and cleanse or change their boots and clothes.

Kind of Water Necessary for the Manufacture of Ice.

To obtain the desired clean, clear, transparent ice, it was, as we have seen, formerly necessary to secure water free from air, mineral salts, or gross impurities. About half of this water was available from the condensed steam necessary to run the plant, and the remainder was generally distilled, sometimes redistilled.

Distillation destroys disease germs, and therefore whatever the source of the water supply there was no danger from that source.

But with the use of the newer can and plate systems distillation is not always necessary, and while manufacturers always endeavor to secure a constant source of pure, clear water of even, low temperature and use such distilled water as is available, it is quite important to remember that so far as the original water is concerned the water may be no better and is sometimes worse than the city supply. The danger of disease germs entering containers in either system depends upon the intelligence and conscientiousness of the manufacturer and the enforcement of municipal laws by proper authority.

Mechanically made ice is not usually stored for long periods, but is made when needed and sold as soon afterwards as practicable.

Briefly, then, both natural and artificial ice are formed from water which contains or may contain pollution, and this pollution may be infectious—that is, may contain the organisms which cause typhoid fever and other water-borne diseases. Both are subject to infection by men walking on or over and handling them, and in either the latter danger may be obviated by, in one case, cutting off the top ice, and in the latter case by cleanliness of workmen and building.

They differ materially in that natural ice is collected and stored for several months before shipment, while artificial ice is generally marketed promptly after it is manufactured.

Does Ice Convey Infectious Diseases?

Very soon after the discovery of the cholera vibrio by Koch and the typhoid bacillus by Eberth it was learned that these diseases were spread largely by water infected by the causative organism, and scientists studied the viability of the organism under varying conditions and environments. It was promptly shown that, while moderate heat for a few minutes (60° C. for 20 minutes) would kill all such germs, some will resist cold for a long time.

The normal habitat of such organisms is the human body, and it is not probable that they ever normally increase in ordinary water,

where they are exposed to an unfavorable environment. It has been shown that time is an important factor in their death, even more than low temperatures. It is an established fact that the typhoid-fever organism lives longer in cold water than it does during the hot months.

Acting upon this knowledge, scientists began freezing large numbers of typhoid organisms in water under laboratory conditions and some few of the germs were found alive after several weeks. In addition to such experiments, sanitarians found that feces from typhoid patients, when thrown on the ground during the snow and ice periods of winter, remained dangerous until spring, and that when washed into streams after the thaw they caused such epidemics as that at Plymouth, Pa. Instances multiplied in which typhoid fever epidemics were traced to pollution of the river from which the water supply of the community was drawn, the point of pollution being, in some instances, many miles distant.

It was known that some typhoid fever organisms lived for several weeks at low temperatures and it was known that large quantities of ice were cut and harvested from polluted rivers, such as the Hudson. It was therefore perhaps quite natural that the guardians of public health in the various States and sanitarians generally should have aroused the public to the dangers from infected ice and even to have ascribed some epidemics to its use. Indeed, in view of the universal use of ice in this country, it is remarkable that so few infections have been ascribed to its use. Prof. Whipple has well expressed the truth:

Now, qualitatively the early bacteriologists were right; quantitatively they were wrong.

There are three great factors in the purification of ice formed from polluted waters. First, as we have seen, crystallization or the formation of ice itself expels a very large proportion, probably 90 per cent, of the organisms. This can occur only if there be free water. Hence, in ice cut from shallow ponds frozen solid, in ice "flooded," and in old-method can ice all impurities, including disease organisms, are retained, alive or dead, in the ice.

Second, freezing destroys a large percentage of typhoid bacilli. Sedgwick and Winslow found in one experiment that only 41 per cent were alive 15 minutes and 22 per cent 6 hours after freezing. More important than this even is the factor of time, for neither water nor ice are suitable media for the multiplication of typhoid bacilli, and there is a progressive decrease. So far as this element is concerned, it is manifest that natural ice has the advantage of longer storage.

The various methods which nature has provided for purifying ice made from polluted waters have been carefully studied by the most competent scientists in our country and abroad.

Purification by crystallization.—Edward Bartow, director of the Illinois State Water Survey, found in one case, with 12,000 bacteria in the raw water, that there were but 125 in the ice; in another, 520 were reduced to 3, 675 to 6, 1,400 to 16, and 4,060 to 22. In every case there was practically 99 per cent reduction. Gas-forming bacteria (which may indicate the presence of typhoid) were also greatly reduced.¹

Dr. Hibert W. Hill, director of epidemiology for the Minnesota State Board of Health, has told us of ice taken from rivers known to be polluted which proved safe, and Dr. Porter has shown the same thing to be true of ice from the Hudson River.

Edwin O. Jordan, professor of bacteriology in the University of Chicago, tested 18 lakes, rivers, and ponds in New England and found, on the average, the unfrozen water to contain 34 times as many bacteria as the freshly formed ice, a reduction of about 98 per cent. Regarding the effect of storage, Prof. Jordan says:

All investigators are now agreed that three weeks after freezing less than 1 per cent, and possibly less than one-half of 1 per cent, remain alive.

Elaborate experiments conducted by Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology; Prof. C. E. A. Winslow, of New York; and by Dr. W. H. Park, of the New York City Department of Health, show that only from 1 to 10 per cent of the bacteria in water are included in ice frozen from it, and that of these about 90 per cent (96.4 per cent according to Sedgwick and Winslow and 86 per cent according to Park) die within a week and 99.8 per cent die within three weeks; so that only one-tenth of 1 per cent of the original number remain.

Prof. Gustave Ruediger, of the University of North Dakota obtained similar results.

George C. Whipple, professor of sanitary engineering at Harvard University, in reviewing the work upon ice, said:

The results correspond roughly with the purification that takes place in a water filtration plant. It may be said, therefore, speaking broadly, that the water that may safely be used after filtration may also be safely used after natural freezing if it is not interfered with by tapping or flooding.

The Dangers in Ice.

We have seen the wonderful forces of nature which exert themselves in purifying ice—crystallization, temperature, time. These constitute the triune force. But it must not be concluded that there can be no danger of ice conveying infectious diseases, and for this reason there must be factors of safety.

¹ Bartow, Edward: The sanitary, chemical, and bacteriological examination of ice. Ill. Water Survey Report.

Ice made from pure water in factories which are kept in a clean and sanitary condition, and ice which has been cut from reasonably pure deep ponds, lakes, or streams after natural freezing and stored under sanitary conditions, are about equally safe. Ice made from polluted water, in dirty insanitary factories, and ice that is cut from shallow polluted ponds or from grossly polluted rivers, such as streams containing large masses of feces or which have been flooded with polluted waters, will contain intestinal organisms and are not safe. Any dirty, cloudy ice may be infected as well as polluted and should not be used in contact with food or water.

The greatest danger connected with ice is the improper handling of this article of food. If ice is dragged across dirty streets and sidewalks, and distributed by hands which are not clean and often contain typhoid and other disease germs, there is some danger from it.

One would not knowingly drink water into which a servant or train employee had dipped his hands; and it is in large measure to avoid danger from contact with the hands of typhoid carriers and other infected persons that regulations have been issued by the Public Health Service looking toward the safeguarding of ice used upon passenger trains.

With the ordinary precautions which cleanliness suggests we may answer the question, How often and under what circumstances may ice produce disease? In the language of that eminent authority, George C. Whipple:

The answer of experimental bacteriology, as well as of experience, is, almost never, or so infrequently, that it need never give concern to the water drinker who tinkles the ice in his glass, or to the dealer in food who uses ice to pack his perishable goods.

Briefly, then:

1. Clear ice is, of itself, as free from the danger of conveying infectious disease as we need wish.

2. Dirty or cloudy ice may be dangerous. It should not be placed in water nor on food which is to be eaten uncooked.

3. There may be danger in eating iced foods or using iced drinks if the ice is improperly handled when placed in contact with the drink or food.

4. We may eliminate all danger by avoiding the handling of ice with dirty hands, by washing the ice with pure water, and by using only clear ice.

5. The average laboring person does not always have the opportunity, even if he have the inclination, to cleanse his hands after attending to those necessities of nature which require their use for purposes which almost inevitably result in their contact with excreta

which may contain the organism of disease, even in apparently healthy people.

It is therefore impossible to overestimate the danger resulting from the handling of ice by unknown persons if the ice is placed in direct contact with drinking water. Consequently in hotels, cars, stations, and similar places where intelligent personal supervision is impracticable, those furnishing the water should be instructed, and indeed compelled by law, to adopt such means of cooling water as do not require direct contact of ice and water.